

Spacecraft

Specifications

Weight: 2,700 kg

Size: 5 meters long, 150 cm x 150 cm cross section

Power: 1,200 W from solar array, 28 VDC, 50 A-h NiH battery

Lifetime: 4 years; 5 years, goal

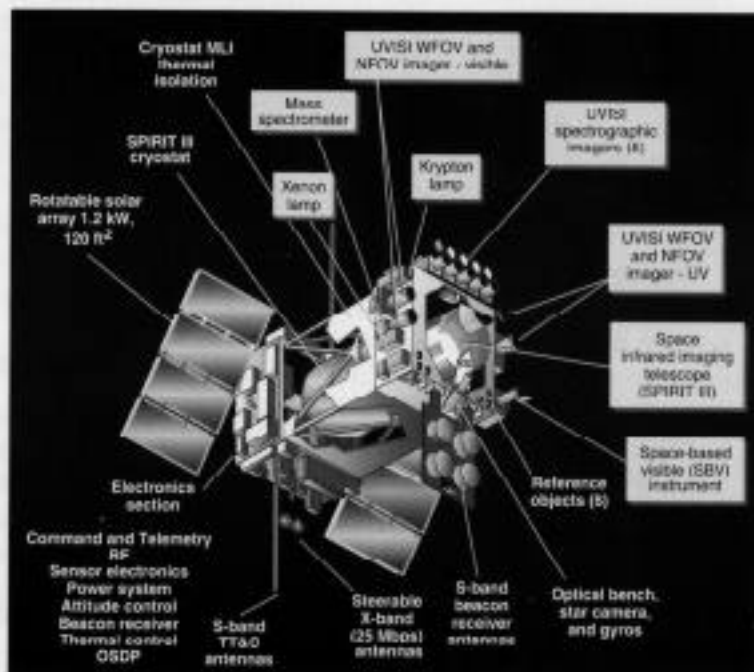
Structural Elements

The spacecraft structure consists of three main sections: the instrument section, the truss structure, and the electronics section. (Instruments on MSX account for approximately 50% of the total spacecraft weight.)

- **Instrument Section**—The instrument section houses 11 optical sensors, which are precisely aligned so that target activity can be viewed simultaneously by multiple sensors. MSX is capable of observations at a wide range of infrared, visible, and ultra-violet wavelengths from 110 nm to 28 μm . The section also carries attitude sensors and the beacon receiver antenna array, which are precisely aligned with the optical instruments. To maintain co-alignment of the sensors, heat pipes are embedded in the aluminum honeycomb panels to keep the temperature even throughout the entire instrument section. A suite of five contamination sensors completes the instrument section.

- **Truss Structure**—A midsection graphite epoxy truss supports the large cryogenic dewar, which contains frozen hydrogen at approximately 9 K. The thermal design of the midsection maintains the outer shell of the dewar at approximately 200 K. The 200-cm-long truss thermally isolates the heat-sensitive instrument section from the much warmer spacecraft bus. Three sides of the truss are covered with multilayer insulation (MLI) to isolate the dewar from the Sun and Earth. The fourth side is left open to cold space for radiative cooling.

- **Electronics Section (Spacecraft Bus)**—This section comprises mainly the spacecraft bus; however, it also carries the warm electronics that are a part of all the instruments. Placement of the warm electronics in this section minimizes thermal dissipation in the instrument section to allow the focal planes to operate as cold as practical.



Subsystems

1. **Attitude Control and Determination**—The attitude control hardware consists of four reaction wheels and three magnetic torque rods. Any three of the four wheels can provide 3-axis control of the spacecraft. Attitude sensors include two 3-axis ring laser gyro systems, a star camera, two horizon sensors, five digital Sun angle detectors, and a 3-axis magnetometer. The attitude sensors are mounted on the instrument section to maintain alignment with the optical sensors. The system achieves real-time pointing accuracy of better than 0.1° and post-processing knowledge to 9 microradians. Line-of-sight jitter is held to ± 9 microradians over instrument integration durations of approximately 1 s. The spacecraft accelerates in the two axes that will change the position of a target within the field of view of the sensors at $0.04^\circ/\text{s}^2$ with a maximum velocity of $3.0^\circ/\text{s}$.

2. **Power**—Two rotatable solar arrays and their drives are derivatives of systems used successfully on the GPS and Delta Star satellites. There are four panels per array, for a total of 120 square feet. A bank of rechargeable nickel hydrogen battery cells provides power storage of 28 volts DC, 50 A-h. The system is designed to deliver up to 2.5 kW. During data collection events, approximately 50% of the available power is used by the instruments.

3. **Command and Data Handling System**—The system includes data encryption and decryption units and two Odetics Model DDS-6000EC tape recorders providing a data storage capacity of 54 Gb per recorder. The prime science data stream at 5 Mb/s NRZ-L can be recorded for up to 3 hours, or at 25 Mb/s for 36 minutes. The data are reproduced in reverse at 25 Mb/s in NRZ L format.

The data handling system provides 16 kb/s housekeeping telemetry, 1 Mb/s real-time science telemetry, various formats at 5 Mb/s for versatile bandwidth allocation to different instruments, and a high-rate 25-Mb/s fixed format to store raw focal plane array data from all instruments simultaneously.

The command system uses a radiation-hardened 1750A processor to execute real-time or up to 14,000 delayed commands. In addition, long loads can be routed to various spacecraft processors (i.e., tracking, attitude, UVISL, SBV, and OSDP) for reprogramming in orbit. The command processor also implements an autonomy function that monitors up to 200 telemetry points for out-of-limit conditions and executes commands to put the spacecraft into a safe configuration.

4. **RF Communications**—This system has two S-band transponders, diplexers, and antenna pairs for command uplink and transmission of the 16-kb/s housekeeping telemetry and 1-Mb/s real-time science data. Also, the SGLS coherent turnaround ranging system is used for orbit tracking. This link is compatible with all of the AFSCN remote tracking stations around the world and the ground station at JHU/APL. The RF system also has two X-band transmitters,

steerable antennas, and antenna controllers for downlinking the tape recorder playback at 25 Mb/s. This link is compatible only with the JHU/APL ground station.

5. **S-Band Beacon Receiver**—The beacon receiver is a passive radar tracker that can acquire a target with an initial pointing uncertainty of $\pm 5^\circ$ at a maximum range of 8,000 km. It provides calibrated angle tracking with a residual error of 0.1° rms. The antenna array contains four 18-inch parabolic reflectors with helical feeds mounted in a graphite epoxy frame on 24-inch centers. Acquisition time at low signal-to-noise ratio is less than 12 s. Central to operation of the beacon receiver tracker is a 4-channel phase-comparison monopulse receiver. It uses digital signal processors for digital beamforming and angle estimation, a 600-MHz direct digital synthesizer for frequency precision and control, and a unique pilot tone injection system for continuous phase and amplitude calibration.

Integration and Test

All work was performed in an ultra-low contamination environment. The spacecraft was assembled in a Class 10,000 clean facility at JHU/APL. It was tested at JHU/APL and at NASA/Goddard Space Flight Center.

Launch Operations

Launch will be on a Delta II 7920 vehicle from Vandenberg Air Force Base. The spacecraft will be inserted into a 900-km, polar, near-Sun synchronous orbit.

Management

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